SCIENCE AND TECHNOLOGY BENEFIT ANALYSIS

Idaho Operations Office – Idaho National Engineering and Environmental Laboratory
Bechtel-BWXT, LLC.

NPOx DECONTAMINATION SYSTEM

The INEEL must cease use of the five tanks of pillar and panel construction in the INEEL Tank Farm Facility (TFF) by the end of 2005, in accordance with the Settlement Agreement. Additionally, an internal driver has been established that mandates discontinuing placement of newly generated liquid waste (NGLW) in the INEEL TFF by the end of 2003. The NPOx Decontamination System was developed to help reduce the volume of NGLW such that these requirements can be met. NPOx Decontamination is an integrated system that includes: 1) metal oxidation in a mild nitric acid/potassium permanganate bath, 2) metal complexing using oxalic acid, 3) metal removal from the solution through a cation exchange column, 4) breakdown of the organic complexing agents using ultraviolet (UV) oxidation in a hydrogen peroxide bath, and 5) solution cleaning and recycle using an anion exchange column. The NPOx Decontamination System is more effective than baseline technologies at removing surface contamination, including radionuclides and hazardous metals, from tools, piping, equipment, and other debris, while significantly reducing the volume of NGLW. The NPOx Decontamination System is being deployed in three phases. The first phase, which was completed on August 23, 2001, included deployment of a 5-liter system in the decontamination cell at the INEEL New Waste Calcining Facility (NWCF). The purpose of this small-scale deployment is to support ongoing optimization activities and to determine the life of the ion exchange columns. Several radioactively contaminated tools were processed in Phase 1 and decontamination factors (DFs) of over 23 were achieved for alpha, beta, and gamma contaminants. This is compared to DFs of five to ten for baseline technologies. Phase 2 of this project is deployment of a 45-liter system in FY02 that will be able to process materials with up to 100 mR/hr radiation fields. A fully automated system with UV oxidation has already been designed and constructed, and optimization testing is ongoing. Phase 3 will be deployment of a 250-liter system in FY04. This will be based on the optimized design validated in Phase 2, and will be able to process remote-handled materials (i.e. 200mR/hr) , including debris with hazardous metal contaminants.

Qualitative Benefit Analysis

Programmatic Risk	◒	The NPOx Decontamination System will reduce the volume of NGLW, resulting in lower clean-up costs at the INEEL, and reducing the EM compliance funding gap.
Technical Adequacy	●	The NPOx Decontamination System achieves higher DFs and generates lower NGLW volumes compared to baseline technologies.
Safety	◒	One of the baseline technologies uses 2.0M nitric acid to decontaminate, while the NPOx system uses only 0.2M to 0.3M nitric acid.
Schedule Impact	○	Project schedules will not be significantly impacted.

● Major improvement | ◒ Some improvement | ○ No change | ◓ Somewhat worse | ◉ Major decline

Quantitative Benefit Analysis

Cost Impact Analysis	Cost avoidance was achieved by reducing volume of waste generated. Phase 1 of the project is accredited with 25% of the overall calculated cost avoidance.	
	Annual Savings	$68.8K
	Life Cycle Cost Savings	$1.38M
	Return-On-Investment (ROI)	8%

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Addendum to NPO_x Decontamination System

This deployment satisfies need ID-2.1.16

Worksheet 1: Operating & Maintenance Annual Recurring Costs

Expense Cost Items *	Before (B) Annual Costs	After (A) Annual Costs
1. Equipment	$ -	$ -
2. Purchased Raw Materials and Supplies	$ 9,504.00	$ 424.00
3. Process Operation Costs:		
Utility Costs	$ -	$ -
Labor Costs	$ -	$ -
Routine Maintenance Costs for Processes	$ -	$ -
Subtotal	$ -	$ -
4. PPE and Related Health/Safety/Supply Costs	$ -	$ -
5. Waste Management Costs:		
Waste Container Costs	$ -	$ -
Treatment/Storage/Disposal Costs	$ 455,000.00	$ 188,825.00
Inspection/Compliance Costs	$ -	$ -
Subtotal	$ 455,000.00	$ 188,825.00
6. Recycling Costs		
Material Collection/Separation/Preparation Costs:		
a) Material and Supply Costs	$ -	$ -
b) Operations and Maintenance Labor Costs	$ -	$ -
Vendor Costs for Recycling	$ -	$ -
Subtotal	$ -	$ -
7. Administrative/other Costs	$ -	$ -
Total Annual Cost:	$ 464,504.00	$ 189,249.00

* See attached Supporting Data and Calculations.

Worksheet 2: Itemized Project Funding Requirements*
(i.e., One Time Implementation Costs)

Category	Cost $
INITIAL CAPITAL INVESTMENT	
1. Design	$ 990,000
2. Purchase	$ 585,000
3. Installation	$ 125,000
4. Other Capital Investment (explain)	$ -
Subtotal: Capital Investment= (C)	$ 1,700,000
INSTALLATION OPERATING EXPENSES	
1. Planning/Procedure Development	$ 130,000
2. Training	$ 70,000
3. Miscellaneous Supplies	$ -
4. Startup/testing	$ 85,000
5. Readiness Reviews/Management Assessment/Administrative Costs	$ 105,000
6. Other Installation Operating Expenses (explain)	$ -
Subtotal: Installation Operating Expense = (E)	$ 390,000
7. All company adders (G & A/PHMC Fee, MPR, GFS, Overhead, taxes, etc.)(if not contained in above items)	$ -
Total Project Funding Requirements=(C + E)	$ 2,090,000
Useful Project Life = (L) 20 Years Time to Implement: 1 Months	
Estimated Project Termination/Disassembly Cost (if applicable) = (D) (Only for Projects where L<5 years; D=0 if L>5 years)	$ -

TOTAL LIFE-CYCLE COST SAVINGS CALCULATION FOR IPABS-IS

(Before - After) x (Useful Life) - (Total Project Funding Requirements + Termination)

Total Life Cycle Cost Savings Estimate = (B - A) x L - (C+E+D)

RETURN ON INVESTMENT CALCULATION

Return on Investment (ROI) % =

$$\frac{\textit{(Before - After) - [(Total Project Funding Requirements + Termination)/Useful Life]}}{\textit{[Total Project Funding Requirements + Project Termination]}} \times 100$$

$$\text{ROI} = \frac{\text{(B-A)-[(C+E+D)/L}}{\text{(C+E+D)}} \times 100 \quad 8 \quad \%$$

O&M Annual Recurring Costs:				Project Funding Requirements:			
Annual Costs, Before=	$	464,504	(B)	Capital Investment=	$	1,700,000	(C)
Annual Costs, After=	$	189,249	(A)	Installation Op. Exp=	$	390,000	(E)
Net Annual Savings=	$	275,255	(B-A)	Total Project Funds=	$	2,090,000	(C+E)

Note: Before (B) and After (A) are Operating & Maintenance Annual Recurring Costs from Worksheet 1.

* See attached Supporting Data and Calculations.

ESTIMATE BASIS FOR: NPOx DECONTAMINATION SYSTEM DEPLOYMENT

GENERAL

The NPOx Decontamination System deployment will be accomplished in three phases. Phase 1 involves deployment of a 5-liter system in Decon Cubicle #2 at the NWCF. This is a manually-controlled system and does not include a UV oxidation step at this time. The purpose of this initial phase is to provide a basis for increasing operator familiarity with the process and to support optimization of system parameters such as temperature, flow rate, cleaning agent concentrations, residence time, ion exchange resin life/performance,and UV power. Phase 1 was successfully completed on August 23, 2001, when the 5-liter system was deployed and used to decontaminate several radioactively-contaminated tools. Although the system is effective at decontaminating hazardous metals (as defined by the Resource Conservation and Recovery Act [RCRA]) and radionuclides, Phase 1 only addressed low activity (i.e. <20 mR/hr) contact-handled radioactively contaminated components. Phase 2 was also initiated this fiscal year. A 45-liter, fully integrated system with DCS and UV oxidation was designed and constructed in the INEEL Interim Engineering Demonstration Facility. Optimization testing will continue through FY02 in support of a planned deployment at the end of the fiscal year. The 45-liter system will be capable of processing higher activity contamination (i.e. up to 100 mR/hr). Phase 3 of this project includes deployment of a 250-liter system, which will be capable of processing remote-handled (i.e. >200 mR/hr) materials. The sonic bath has already been procured. Design and construction of the remaining system components will be accomplished throughout FY03 and FY04 in support of deployment of the full-scale system in FY04.

INITIAL CAPITAL INVESTMENT

The initial capital investments have been and will be provided by EM-40 INEEL EM Operations and EM-50 Tanks Focus Area funding. For Phase 1, design, purchase, and installation costs were $300K, $60K, and $25K, respectively. This totals $385K for the Phase 1 deployment, based on actual expenditures. For Phase 2, the purchase costs were $250K in FY01, design/fab costs were $415K, plus $50K installation costs at IEDF. An additional $200K of design costs are planned in FY02, for total capital investment of $915K. For Phase 3, the 250-liter sonic bath has been purchased at $100K. Additional capital investments are planned at $175K for equipment purchase, $75K for design completion, and $50K installation, for a total of $400K.

INSTALLATION AND START-UP

Installation and start-up costs for this project include planning/procedure development, training, start-up/testing, and readiness reviews/management assessment for all phases. During the Phase 1 deployment the costs incurred to support these activities were $75K, $25K, $25K, and $25K, respectively. These costs, which total $150K are expected to reduce for the subsequent Phase 2 and Phase 3 deployments since these are primarily scale-up deployments and the resources needed to adapt the existing data and documents to the new systems will be lower than the initial efforts to deploy a new technology. In addition, CH and RH decontamination procedures are already in place for the baseline technologies in use at NWCF. Phase 2 costs are estimated at $35K, $30K, $30K, and $40K, respectively, for a toal of $135K installation and start-up expenditures. Phase 3 costs are estimated at $20K, $15K, $30K, and $40K, rexpectively, for these same components for a total of $105K.

ESTIMATE BASIS FOR: NPOx DECONTAMINATION SYSTEM DEPLOYMENT

TRADITIONAL (BASELINE) TECHNOLOGY/METHOD

Two baseline decontamination technologies are currently in use at the INEEL. For RH wastes, a 2.0M Nitric Acid Bath is used to decontaminate debris and other materials. Based on operational data, this system uses 60 gallons of decontamination solution for each cubic foot of waste treated. For CH wastes, the baseline decontamination system is an Alkaline Potassium Permangate process. Based on operational data, this system uses 15 gallons of decontamination solution for each cubic foot of waste treated. These process typically achieve DFs of five to ten, depending on the configuration and condition of contaminants. Neither system has the ability to recycle the decontamination solution. Annually, these systems generate approximately 1625 gallons, after concentration in evaporators.

NEW TECHNOLOGY/ METHOD

The NPOx Decontamination is an integrated system that includes: 1) metal oxidation in a mild nitric acid/potassium permanganate bath, 2) metal complexing using oxalic acid, 3) metal removal from the solution through a cation exchange column, 4) breakdown of the organic complexing agents using ultraviolet (UV) oxidation in a hydrogen peroxide bath, and 5) solution cleaning and recycle using an anion exchange column. The NPOx Decontamination System is more effective than baseline technologies at removing surface contamination, including radionuclides and hazardous metals, from tools, piping, equipment, and other debris, while significantly reducing the volume of NGLW. The reduced secondary waste volume is priimarily due to the ability of the system to recycle and reuse virtually all of the decontamination solution. The NPOx system has been demonstrated to routinely achieve reductions in waste volume generation in excess of 90%. The NPOx Decontamination process is based on a commercially available Siemens HP/CORD technology; however, some of the process steps use high cost, less stable, difficult to obtain chemicals that are not amenable to deployment at the INEEL. For instance, the original process uses permanganic acid as part of the metal oxidation process. The INEEL NPOx system replaces this with a mild nitric acid and potassium permanganate solution to cost-effectively perform the same process step. The NPOx Decontamination system achieved DFs of 23 during the initial deployment.

COST SAVINGS/COST AVOIDANCE/RISK REDUCTION

The cost avoidance resulting from deployment of the NPOx Decontamination System results from reduced chemical costs and reduced generation of secondary waste volume. The NPOx system replaces the Nitric Acid Wash and the Alkaline Potassium Permanganate processes. These technologies are used on RH and CH wastes, respectively, and result in generation of approximately 65% of the annual generation of 2500 gallons, after evaporation, or 1625 gallons. Costs for treating NGLW range from $280.00 to $413.00 per gallon. For purposes of this cost avoidance calculation, $280.00/gallon will be used. Based on the amount of chemicals purchased annually to support these processes, 200 to 160 cubic feet of waste are processed. The annual quantity of waste treated will be based on the lower amount of 160 cubic feet. Although NGLW reductions of over 90% have been achieved in testing, processing actual wastes are exepcted to be only 75% as effective for CH materials and 50% as effective for RH materials. This correlates to an overall NGLW volume reduction of (0.9) x [(0.6) x (0.75) + (0.4) x (0.5)] = 58.5% volume reduction. At $280.00/gallon treatment costs, this results in (1625) x (58.5%) x (280) = $266,175 annual savings. For each cubic foot of RH waste processed, 60 gallons of decontamination solution are used. For each cubic foot of CH waste processed, 15 gallons of liquid waste are generated. These are pre-evaporation quantities. Based on the chemical composition of the decontamination solutions, the chemical costs are $27.00 per cubic foot of CH waste treated and $108.00 per cubic foot of RH waste treated. The chemical costs of the NPOx System are $1.21 and $4.81 per cubic foot, respectively. This correlates to a chemical cost savings of (160) x [(0.6) x (27.00 - 1.21) + (0.4) x (108.00 - 4.81)] = $9080.00 annually. Completion of Phase 1 constituted a significant portion of the engineering and investment required for full deployment. Phase 1 costs totalled $535K, which represents over 25% of the total project investment of $2090K. Therefore, this deployment is credited with one fourth of the total cost savings

SCIENCE AND TECHNOLOGY BENEFIT ANALYSIS
DEPLOYMENT APPROVALS

Technology Deployed: NPOx DECONTAMINATION SYSTEM

Date Deployed: August 23, 2001

EM Program(s) Impacted: High Level Waste Program

Approval Signatures

9/12/01
Contractor Program Manager — Date

N/A
Contractor Program Manager — Date

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DOE-ID Program Manager — Date

N/A
DOE-ID Program Manager — Date